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MOBILIZING CITIZEN SCIENTISTS IN HURRICANE DISASTER ASSESSMENTS

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ABSTRACT

Hurricane Matthew hit The Bahamas in October 2016 as a Category 3 and 4 hurricane causing an environmental disaster. The Bahamas and other Small Island Developing States in the Caribbean may be facing an increasingly large number of severe storm events in the future as hurricanes and tropical storms are strengthened by unusually warm ocean waters. There needs to be a proactive response to hurricane preparation and mitigation. The Hurricane Matthew Project jointly conducted by Young Marine Explorers, a Bahamian marine conservation organization, and the University of Miami Coastal Ecology Lab studied the impacts of Hurricane Matthew on New Providence. Part of the study looked at the role that citizens can play at proactively preparing for these hurricanes in advance through community mitigation and restoration projects that work in partnership with the government. This study looks at the experience of the citizen scientists who participated in the Hurricane Matthew Project and the potential for mobilize large numbers of people to collect valuable information that can assess hurricane damage and support policy making, while simultaneously developing marine citizenship.

INTRODUCTION

The Bahamas is a low-lying country and extremely susceptible to the effects of climate change. With sea level rise and global warming trends, The Bahamas may be facing an increasingly large number of severe storm events in the future

as hurricanes and tropical storms are strengthened by unusually warm ocean waters (e.g. Sullivan Sealey, 2017). Caribbean nations are exposed to extreme weather events because of their geographical location with disastrous consequences due to their socio-economic state (Cashman and Nagdee, 2017). Over the past three years, the Atlantic basin has experienced devastating hurricanes that have long-lasting impacts on the economy and the well-being of the island residents. The Atlantic basin is infamous for tropical storm activity, having on average 11.7 named storms forming each year between the years of 1900-2016 (Landsea, 2017). Hurricane Matthew, a Category 3 and 4 hurricane on the Saffir-Simpson scale hit The Bahamas on the 5th and 6th of October 2016. The Hurricane came up from the southeast and passed through the entire country. With maximum wind speeds of 225 kilometers per hour, and a maximum rainfall estimated at over 20 cm (Sullivan Sealey, 2017). This hurricane had unprecedented impacts on the people and communities of The Bahamas. Young Marine Explorers (YME), a Bahamian marine conservation organization worked with the Coastal Ecology Lab at the University of Miami (UM-CEL) to document the impacts of Hurricane Matthew on coastal and marine resources. The study, titled the Hurricane Mathew Project, included a rapid impact assessment to document damage caused by the hurricane to the coastal zone, and looked specifically at developed and protected coastal environments along the southern and western coasts of New Providence Island. The project produced maps that illustrated the extent and severity of damage caused by Hurricane Matthew. The results showed that

irresponsible coastal development and the poor environmental decisions that have been made over the past decades in The Bahamas turned a bad hurricane into an environmental disaster by accelerating the rate of coastal erosion, dumping trash including plastic into the ocean, and increasing the pollution loading to nearshore marine habitats (Sullivan Sealey, 2017).

Historically, in The Bahamas, active hurricane preparation begins between a week, to a few days before landfall of the hurricane, and primarily consists of gathering necessary items and securing property. Post storm there is significant dependence on the government to restore private and public infrastructure. Such exclusive dependence on government agencies and the lack of long-term preparation and mitigation of potential storm damage is not sustainable. Citizens of these island nations need to be prepared to not only respond to natural disasters, but also proactively prepare for these hurricanes in advance through community mitigation and restoration projects that work in partnership with the government.

Young Marine Explorers is a non-profit organization with the mission to empower and inspire youth to restore and protect our marine ecosystems through education, leadership, stewardship, and citizen science, ultimately fostering positive behavioral change that drives conservation. Over the past ten years, YME has worked within the public-school system in New Providence offering marine science and youth development programs for senior high school students, working with over 1200 students. YME's role in the Hurricane Matthew Project was to engage citizen scientist. Recent high school graduates and high school students worked with the UM-CEL to collect data. The intent of this partnership was to look at how citizens and community members can become actively engaged in disaster response assessments, and to encourage citizens to take greater personal responsibility for hurricane preparation and mitigation. This project has laid the foundation for the expansion of the role of citizen science projects in the Young Marine Explorers programs. Additionally, it has increased our interest in conducting citizen

science projects with the ability to inform data-driven decisions at the policy and management level.

STUDY SITE AND CITIZEN SCIENTISTS

The Hurricane Matthew Project focused on New Providence Island, the most populated island in The Bahamian Archipelago which spans 1,200-km in the Tropical Western Atlantic Ocean. The study focused on Southern New Providence and the citizen scientists participating in this study lived within the study region. Citizen science is the practice of using members of the general public to collect quantitative information in collaboration with scientists. Two groups of citizen scientists were used in this study. The first were high school students between the ages of 14 and 17. These high school students were enrolled in a Young Marine Explorers after school program and had between one to two years' experience in marine education and stewardship activities. The second and more engaged group in this study was the YME interns who had completed three years of the YME stewardship program and were participating in a two-year internship that exposed student to marine conservation projects in The Bahamas. Interns were recent high school graduates with no formal scientific training or college experience and received a small stipend for their commitment to the internship. All citizen scientists participating in this study were from low income and under-served communities.

METHODS

Before participating in the data collection processes of the Hurricane Matthew Project, the citizen scientists needed to be trained to ensure that the data collected was reliable. To facilitate this training the University of Miami's Coastal Ecology Lab created training videos and a Field Methods Manual. The Field Methods Manual has nine sections: 1) An introduction to the Hurricane Matthew Project and Citizen Science, 2) Building Damage Ranking Protocol, 3) Vegetation Damage Ranking

Protocol, 4) Flood Severity Ranking Protocol, 5) Solid Waste Assessment Underwater and Coastal Protocol 6) Coastal Assessment Protocol, 7) Sediment Sampling Protocol, 8) Water Quality and Biodiversity Assessment Protocol, and 9) Quality Assurance Protocol. The five interns watched the different training videos and participated in an hour-long question and answer period following each video. The field manual was carried into the field and referenced continually. A scientist accompanied the five interns in the field. The scientist served as a reference and was able to answer questions and provide guidance when needed. At times the intern and scientist team worked as a unit conducting assessments around New Providence. Some data collection trips included high school students where each intern led a group of ten high school students in the data collection protocols. Interns were engaged in four components of the Hurricane Matthew Project. First, YME worked with students to document hurricane impacts in their neighborhoods and encourage students to share their hurricane experiences. Second, students worked with mentors from University of Miami to carry out coastal assessments in key locations around New Providence documenting coastal erosion, loss of vegetation, flooding and destruction of homes and buildings. Third, students participated in water quality sampling and learned about water quality and land-based sources of pollution to coastal water and what that means for the health of coral reefs and the impact that it can have on our economy. And fourth, students learned about mapping hurricane impacts along the coast and in the water. Data from the field were entered into Excel spreadsheets. Before sending the data to UM-CEL, the data were quality controlled by a scientist by reviewing the data to make sure that rankings were correctly assigned. The data was quality controlled an additional time by the UM-CEL lab. A digital survey tool was created to assess the interns experience during the Hurricane Matthew Project and to inform the development of future citizen science projects. The assessment tool looked at four different components of the Hurricane Matthew Project citizen science experience: 1) problems

encountered during the project, 2) participants understanding of the project, 3) the training experience, and 4) attitudes about hurricane preparation and personal responsibility. Interns completed the survey upon completion of the Hurricane Matthew Project.

RESULTS

Problems

Before the Hurricane Matthew Project was completed, one of the five interns left because her stipend was not sufficient. Although some participants were satisfied with the pay, fifty percent said that they did not receive enough money. The problems that the interns highlighted were about the logistics of the data collection. The participants suggested that starting the project a few days or a week after the hurricane as opposed to waiting a few months would improve the data collection processes, especially when interviews were conducted. Participants were not extremely interested in the data entry component of the project and required direction and encouragement to enter the data. When the data were entered into the Excel spreadsheet, there were a number of errors. The errors were caught by the reviewing scientists and corrected before the data were submitted to the UM-CEL.

Perception

Participants said that their perspective on hurricane response had changed since their participation in the Hurricane Matthew Project. All participants said that they would be likely to participate in another citizen science project and were in agreement that Bahamians should be very involved in hurricane disaster assessments. Additionally, they were in agreement that there should absolutely be a similar project to the Hurricane Matthew Project after the next hurricane. Furthermore, when asked if mangroves and beach dunes can protect people's home and property from hurricanes, scores were '4' and '5', where '5' represented that

mangroves and dunes protected property and homes, and '1' represented that mangroves and dunes provided no protection.

About the project

When asked to describe the objectives of the Hurricane Matthew Project, all participants were able to articulate that the project was intended to assess the damage that Hurricane Matthew caused to New Providence Island and to identify the most negatively impacted areas. Additionally, interns mentioned that the study looked at the role that coastal development played on exacerbating the storm impact. All participants believed that the data collected were to be used to inform the government and to identify ways to prevent the scale of damage from occurring again. All participants agreed that the Hurricane Matthew Project was important and that they learned a lot through their participation in the project.

Training

Participants felt that the training was good. However, there was a difference in opinions about how helpful the training videos were at preparing interns to collect that data. Fifty percent of participants stated that the videos were not very helpful while the other fifty percent said that they were helpful. One of the participants stated that "a more hands-on training would have been preferred as the videos provided weren't beneficial and I couldn't remember most of the things [from the video]." When asked to provide other comments about the Hurricane Matthew Project, two participant responses were received. The first stated that, "The Hurricane Matthew Project was a great learning experience. A goal should be to get more young persons to participate in it as they will learn [more] about hurricanes [while participating] in the project than they will sitting down in a classroom reading books or watching videos." The second comment suggested that, "We should get the youth more involved in projects like these. Maybe communicate with schools to set up a school field trip whereas

the students go out and conduct the study. Or maybe the University of The Bahamas students can take part in the study for extra credit."

DISCUSSION

The Hurricane Mathew project demonstrated how citizens and specifically youth can become actively engaged in disaster response and storm mitigation while developing critical life skills. There is a need for community stewardship programs that engage citizens in long-term biodiversity monitoring and ecosystem restoration. The methodology used in these monitoring programs should be adaptable to allow for post disaster assessments that serve as resources for planification and policy making. By engaging citizens in the Hurricane Matthew Project, we were expanding the role of hurricane response and mitigation to Bahamian citizens. One of the main objectives of the Hurricane Matthew Project was to use citizen scientists to collect information capable of informing data-driven policies.

Validating the data

A critical component of this citizen science project was the partnership with The University of Miami Coastal Ecology Lab. This allowed for the development of the training materials and protocol that the citizen scientists used. Although there is room to refine the citizen science training tools and data collection process, working directly with UM-CEL was a critical step to ensure quality of data. It was important to have the citizen scientist work closely with a scientist in the field. Additionally, the data entry quality control protocols were critical in addressing any human errors.

Socioeconomics of Citizen Science

The citizen scientists engaged in the Hurricane Matthew Project came from underserved and lower income communities. Unlike some citizen science projects such as EarthWatch, where

citizens pay an average of three thousand dollars to participate in a project (EarthWatch, 2017), the students participants in the Hurricane Matthew Project were participating in YME as an academic enrichment and extracurricular activity. The interns, participating in an internship received a small stipend. Unfortunately, the stipend offered by the Hurricane Mathew Project was not high enough to keep all the interns happy and one intern quit the project to take a job. The notion of an unpaid internship or stipend internship is not a sustainable model for long-term citizen science projects intended to inform policy, especially if the citizen scientists are from low income or underserved communities. There is, however, great potential to use citizen science projects as part of a structured youth development program for high school students while providing skills to youth from underserved communities. This can be mutually beneficially where the data they collect supports biodiversity monitoring and disaster response, and in exchange students are engaged in inspiring and fun activities.

Marine Citizenship

There is a need to develop the individual responsibility for disaster response management. Citizen science projects can play a role in this but must be coupled with a marine citizenship program that focuses on developing sustainable behavior. Marine citizenship is “the act of citizens taking greater personal responsibility for the oceans, as a policy channel to support the delivery of a healthy marine environment and to enhance marine governance” (McKinley and Fletcher, 2012). This builds on the existing model of citizenship, the central component of which is the relationship between an individual member of society and the state to which it belongs (McKinley and Fletcher, 2012, Purcell, 2003, Chamberlin, 1997). The conversation of marine citizenship expands the role of conservation and includes topics such as governance, democracy, accountability, social justice, personal responsibility, and the capacity to act (McKinley and Fletcher, 2012, Matti, 2006, Cruz, 2008, Donert,

2003). Marine citizenship transforms the role of conservation into an individual matter, because this is what needs to be done with disaster response management. A marine citizenship curriculum should be part of all disaster response citizen science projects.

Restructuring Young Marine Explorers

Over the past ten years, Young Marine Explorers has been addressing: 1) the lack of marine citizenship, 2) the poor educational output of youth in Bahamian Public Schools, and 3) the lack of professional and personal skills in Bahamian youth. These issues have been addressed by offering a three-year program for senior high school students that uses a marine citizenship curriculum that reinforces the Bahamian Ministry of Education learning objectives for math, biology, language arts, and geography, thus further preparing youth for their national exams. The marine citizenship curriculum fosters leadership and personal development and equips youth with the skills required to enter the workforce. As a result of the Hurricane Matthew Project, YME has added two additional issues to our agenda to address. The first is the lack of data for data-driven environmental decisions to be made. The second is the lack of capacity to gather large datasets about biodiversity and environmental disasters. To address these issues, we have redesigned our three-year curriculum so that it includes the aforementioned marine citizenship curriculum in addition to conducting citizen science projects that are designed to monitor biodiversity and conduct post-disaster assessments over long periods of time. The new YME program: 1) supports the personal development of young professionals and reinforces the importance that the ocean has in supporting Bahamian health and wellbeing; 2) develops environmental leaders who understand the function of Bahamian ecosystems and value the role of ecosystem services in supporting the Bahamian population; and 3) cultivates active citizens who understand the importance of and contribute to creating a sustainable Bahamas through their participation in citizen science projects.

The future for Young Marine Explorers

The future plan for YME is to increase youth participation in long-term citizen science projects within The Bahamas. Citizen science programs have the capacity to drive conservation action through monitoring biodiversity, restoring ecosystems, assessing disasters, and contributing towards natural resource management. Young Marine Explorers has relocated our operations from New Providence to Cat Island, a remote Bahamian family island with a population of 1500. This move is reflective of our shift to focus on community-driven conservation and align our programs in support of achieving the United Nations's Sustainable Development Goals. We have identified eight UN Sustainable Development Goals that through our work, we are directly supporting. To truly achieve our environmental conservation objectives, we need to fully engage the local communities. Working within a smaller community like Cat Island will allow for us to better apply our methodology, engage all stake holders, and demonstrate the success of our model. YME will spend the next five years working in Cat Island implementing the YME marine citizenship curriculum within the two high schools on the island and implementing a long-term biodiversity monitoring citizen science project. The protocols adapted from the Hurricane Mathew Project will enable citizen scientists to be prepared to assess damages after the next hurricane. The five-year time frame will allow us to monitor trends in biodiversity, community engagement, and marine citizenship development.

CONCLUSIONS

The Bahamas and other Small Island Developing States (SIDS) do not have the luxury to only think about hurricanes during the hurricane season. Neglect and lack of preparation will cost money and resources needed to move SIDS forward towards improving the lives of residents, measuring nation building against the UN 2030 agenda, and meeting the multilateral agreements

that we are party to. Hurricanes and natural disasters could be the single largest threat to national development in the region. Partnerships are critical to collecting information and developing data-driven policies for coastal protection and management. Civic organisations like Young Marine Explorers have the capacity to mobilize large numbers of people to collect valuable information that can support planning and policy making, while simultaneously developing marine citizenship. There is a need to replicate programs like Young Marine Explorers throughout the region in a proactive effort to prepare for hurricanes in advance through community mitigation and restoration projects that work in partnership with the government.

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